Functionalization of Two-Dimensional Transition Metal Dichalcogenide-based Phototransistors with Photoactive Molecules

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Transition metal dichalcogenides (TMDs) are attracting increasing interest as a platform for optoelectronic applications such as photodetectors, light-emitting devices and solar cells [1]. Its unique crystal structure allows tuning its properties by mechanical, electronic and optical excitations, and combining different properties by forming heterostructures or chemical intercalation [2]. In this work, we have fabricated transistors based on mechanically exfoliated monolayers of TMDs, and functionalized with photoactive molecules deposited on top. We report the doping effect of the molecules by measuring gate tunability and wavelength dependant photoresponsivity, where it is observed an exciton-dependant enhancement of the photoresponse, different for each semiconductor. This defines a path for molecular tailoring of two-dimensional optoelectronic devices.

References

[1] D. Jariwala, V. K. Sangwan, L. J. Lauhon, T. J. Marks, and M. C. Hersam, ACS Nano, 8 (2014) 1102
[2] H. Wang, H. Yuan, S. Sae Hong, Y. Li and Y. Cui, Chem. Soc. Rev., 44 (2015) 2664

Figures

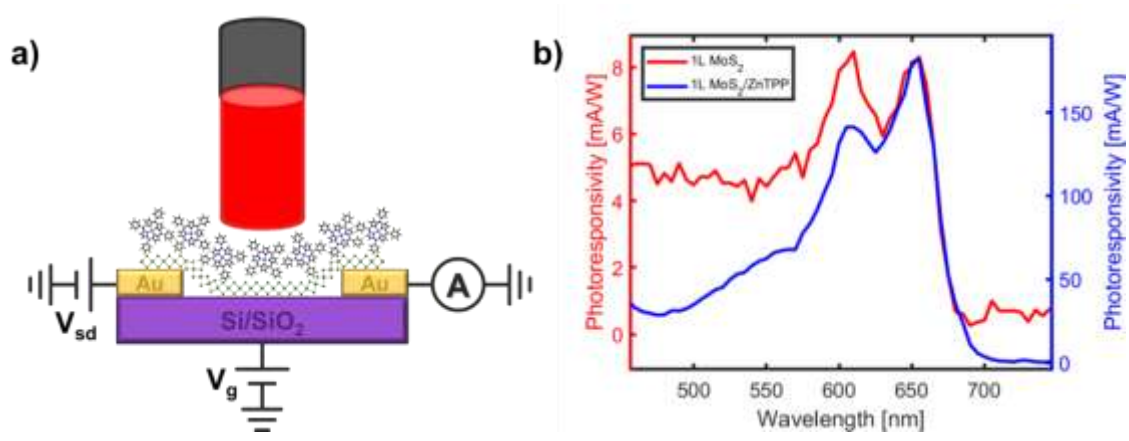

Figure 1: (a) Conceptual image of the measurements. A device consisting of a single layer of MoS_2 stamped on patterned gold electrodes evaporated on Si/SiO_2, and functionalized by deposited ZnTPP molecules. The Si is contacted for gate tuning and the gold electrodes are connected as source-drain for applying a bias voltage and measuring current. LEDs are used to excite the device with light of different wavelengths. (b) Wavelength dependence of the photoresponsivity for a single layer MoS_2 device before (red) and after (blue) functionalization. It is noticeable the increase in the photoresponsivity after depositing the molecules, higher for wavelengths around exciton A peak than for exciton B peak.